DOCUMENT RESUME

ED 199 029 SE 033 236

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TITLE A Factor Analytic View of Adolescent Thought in Piagetian Context.
INSTITUTION Regional Coll. of Education, Ajmer (India).
PUB DATE 80
NOTE 12p.: Not available in hard copy due to marginal legibility of original document.

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Adolescent Development: *Cognitive Development: *Cognitive Measurement: Cognitive Processes: Cognitive Tests: *Developmental Stages: Developmental Tasks: Elementary Secondary Education: *Factor Analysis: *Literature Reviews: Science Education
IDENTIFIERS Piaget (Jean): *Science Education Research

ABSTRACT

Research is described concerning a factor analytic view of adolescent thought in Piagetian context. Included are a description of Piagetian tasks used for determining stage of mental development, studies concerning Piagetian task factor analysis, and the current factorial structure of adolescent thought. (DS)

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ED199029

A Factor Analytic View of Adolescent Thought in Piagetian Context

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A Factor Analytic View of Adolescent Thought in Piagetian Context*

With the persistent efforts made under the leadership of Professor Jean Piaget, the work of Geneva School has come of age in this decade Being influenced by the genetic epistemology, he propounded a stage-wise theory of intellectual development which ran counter to the currently held psychometric view of intelligence. His views could not be confirmed or rejected because of the 'Methode Clinique' which he himself developed and used. (It is a highly imaginative but, at the same time, a most-consuming technique in the collection of data on pupil thought.) Secondly, another serious handicap here was the use of unconventional methods and tools, lacking scientific vigour. Despite these two difficulties, quite a few workers have attacked the Piaget's formal stage whose main characteristics of this complex stage are :

(i) The adolescent pupil's thinking is no longer tied to the concrete situations.
(ii) He imagines and considers all sorts of facts, hypotheses and possibilities.
(iii) He develops the ability to reason by hypotheses.
(v) He goes even to the extent of finding empirial and mathematical proof for his observations.

It is not difficult to grasp the above mentioned characteristics in isolation. But the feel of difficulty is reflected when he suggests certain schemes of thought along with their corresponding experiments If the current status of research in this field is evaluated, one really draws a blank. The schemes of thought along with their experiments as suggested by him are as follows :—

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* ERIC NCERT PROJECT : The Determination and Development of Schemes of Thought in Science During Adolescence Under the Direction of Professor N VAIDYA

S. No.	Scheme	Experiments
1.	Combinations	Chemical combinations, in a system containing a substance to be coloured: a dye, an inhibitor, and a neutral agent.
2.	Proportionality	Equilibrium on a balance beam where the multiplicative relation between length and weight must be dealt with.
3.	Correlations and Probability	Discovering the relations between a pair of imperfectly correlated variables (hair and eye colour).
4.	Conservation beyond empirical experience	Conservation of movement in a system containing some friction, i. e., rolling balls on a horizontal plane.
5.	Inversion and reciprocity coordinated in maintenance of equilibrium	Behaviour of liquid in communicating vessels (equality of water levels, relation between water pushed out of one tube and into the other).
6.	Mechanical equilibrium	Hydraulic press (a more quantitative version of the preceding).
7.	Coordination of two reference systems	Snail moving on moving platform.
8.	Equilibrium of work mechanical proportion	Behaviour of wagon on variably inclined plane counter balanced by variable weight on pulley.
9.	Geometrical proportionality	Predicting size of shadow cast with objects varying in size and distance, screen and source varying in distance.
10.	Compensation of interacting variables	Behaviour of balls on rotating platform, relation between weight and distance from centre in determining centrifugal motion.

At this stage, it is necessary to say a few words about the schemes of thought and how the transition of thought takes place from the concrete stage to the formal stage of mental development. Regarding the 'Scheme of thought', the following terms more or less loosely cover it : 'Strategy, concept, plane, decision, process, orientation, sequence of links, learning set and key factor having past, present and future.' In this context, the conditions of transition from the concrete stage to the formal stage, according to Jean Piaget are :

1. The adolescent pupil is in a position to state as well as test hypotheses. This type of reasoning is called the hypothetico-deductive one.

2. The adolescent pupil is able to make the effective use of proportional logic.

3. The adolescent pupil is in a position to separate form from content. Where possibility rather than reality becomes the chief distinguishing characteristic of his thought.

4. The adolescent pupil is able to deal effectively with the entire combinatorial nature of operations that is, from the 16 binary combinations to 256 tertiary operations.

5. The adolescent pupil is in a position to generate all the possible cases which are derivable from 'one single identifiable mental structure i. e. the INRC group. It is a fascinating mental structure arising from the fusion of two different structures,' namely, the lattice and the group of reversibilities

The Presentation of Studies

Vaidya (1964) investigated problem solving among certain group of adolescent pupils in Central London. The problems selected from physics inhered the following schemes of thought : Schemes of summation, constant difference, conservation, proportion, categorization, stating as well as testing hypotheses and discovery of principles from incompletely supplied data. Using Hotelling method,

four factors appeared namely, Attainment factor, Practical factor, Interest factor and Adjustment factor. Working with highly restricted age group of grade X,. Mishra and Vaidya (1974) investigated the role of hypothesis formation and testing in learning of science and showed the existence of five factors, namely, General Adjustment, Ability to see the problem as a whole, Formulating hypotheses, Interest in generating difficult problems and Newness of the problem.

In another comprehensive study using case study approach, Vaidya (1975) investigated certain aspects of thought among certain groups of adolescent pupils (N=200) with the help of seventeen problems, each inhering a continuous chain of reasoning. His study showed the existence of the following ten factors: Schematic learning general adjustment, Problem learning general adjustment, Problem orientation, Sensing problems, Symbolization, Testing hypotheses, Using constant difference, Aspect character, Seeing the problem as a whole and Intelligence.

As a part of an ERIC project, Sandhu (1980) investigated the structure of formal thought with the help of ten Piaget Type tasks loaded with scientific contents on 986 adolescent pupils drawn randomly among the students of twelve high schools of rural areas in Punjab taking almost equal number of boys and girls belonging to the age groups of 11+, 12+, 13+, 14+, and 15+ studying in grades 6 to 10 respectively. The analysis of his data indicated the following factors General intellectual factor, Academic achievement factor, Adjustment factor, Behavioural factor, Emotional factor, Temperamental factor, Group factor of adolescent thought and Social factor.

Lawson (1975) showed that the tasks used by Piaget measured formal reasoning. It is also of interest to add here that according to him the formal of the test affected males and females differentially. Using cluster analysis technique, only one factor appeared in the acquisition of algebraic concepts during the secondary school years in a study by Joshi (1970). However, the centroid method clearly hinted at the existence of two factors, namely, abgebraic aptitude and symbolic substitution in the same study too.

As already pointed, it is difficult to collect data in Piagetian context on Piagetian thought using the clinical method. So other workers like Longeot, Raven, Shayer, and Wharrey, Tisher, Staver and Gabel have attempted to develop paper-pencil tests for investigating adolescent thought. All of them have

extracted factors using different tasks and tests, populations and techniques of analysis. The result of all these studies indicate that the formal stage which appears during adolescence is just being scratched factorially. Also there is yet to become available a single study investigating Piagetian thought in full without violating the underlying assumptions. If some pointers in this direction are any guide towards the clarity of the field, structurally speaking, the developing picture is somewhat as follows :

(i) Piagetian tasks as given in the Growth of Logical Thinking as well as tasks inhering a continuous chain of reasoning, measure what is called 'formal thought' (Bart, Gabel, Gurein, Lawson, Lovell, Lunzor, Misra, Peel, Renner, Sandhu, Shayer, Staver and Vaidya)

(ii) Formal thought is necessary to proportional reasoning (Lovell and Lunzer etc.)

(iii) The structure of formal thought is bi-factorial, viz, Verbal and Non Verbal (Bart).

(iv) Analytic thinking, intuitive thinking and strategy appear during adolescence. (Abou Hatab, Austin, Goodnow and Guilford).

(v) Adolescent thought shows a form of grouping : Concrete operational and coordinating concrete-logical (Gurein).

(vi) The factorial structure sex-wise during adolescence is not the same on Piagetian type Tasks presented individually as well as in a group (Lawson and Vaidya).

The Current Factorial Structure of Adolescent Thought:

The consolidated factorwise picture as currently obtains in literature is as foll.

The Current Picture

S. No.	*Factors*	*Psychological Interpretations*	*Authors*
1.	First Factor	(i) General Intellectual Factor	Abou Hatab, Beard, De-Lemos, Mac Arthur, Peel, Sandhu, Staver and Gabel, Tuddenham, Vernon.
		(ii) Schematic Learning General	Bart, Renner and Lawson, Vaidya
		(iii) General Adjustment	Vaidya and Misra
		(iv) Formal Operational Thought	Abramowitz
		(v) Exclusion of Variables	Shayer
		(vi) Attainment Factor	Vaidya
		(vii) Algebraic Aptitude	Joshi

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2.	Second Factor	(i)	Piagetian Cognitive Development	Staver and Gabel
		(ii)	Seeing the Problem as a whole	Vaidya and Misra
		(iii)	Academic Achievement Factor	Sandhu
		(iv)	Adjustment	Vaidya
		(v)	Practical Factor	Vaidya
		(vi)	Symbolic Substitution	Joshi
3.	Third Factor	(i)	Piagetian Logical Operations Test	Staver and Gabel
		(ii)	Formulating Hypotheses	Vaidya and Misra
		(iii)	Adjustment Factor	Sandhu
		(iv)	Problem Orientation	Vaidya
		(v)	Interest Factor	Vaidya
4.	Fourth Factor	(i)	Interest in Generating difficult problems	Vaidya and Misra
		(ii)	Behavioural Factor	Sandhu
		(iii)	Sensing Problems	Vaidya
		(iv)	Tackling Algebraic Symbols	Vaidya
		(v)	Adjustment Factor	Vaidya
5.	Fifth Factor	(i)	Newness of the Problem	Vaidya and Misra
		(ii)	Emotional Factor	Sandhu
		(iii)	Problem Orientation	Vaidya
		(iv)	Symbolization	Vaidya
6.	Sixth Factor	(i)	Temperamental Factor	Sandhu
		(ii)	Testing Hypotheses	Vaidya
		(iii)	Using Constant Difference	Vaidya
7.	Seventh Factor	(i)	Group Factor of Adolescent Thought I	Sandhu
		(ii)	Aspect Character	Vaidya
		(iii)	Using Constant Difference	Vaidya
8.	Eighth Factor	(i)	Social Factor	Sandhu
		(ii)	Aspect Character	Vaidya
		(iii)	Exclusion of Variables	Vaidya
9.	Ninth Factor	(i)	Combinational grouping	Vaidya
		(ii)	Seeing problem as a whole	Vaidya
		(iii)	Group Factor of Personality I	Sandhu

10. Tenth Factor	(i)	Intelligence	Vaidya
	(ii)	Verbal Description procedures	Vaidya
	(iii)	Abstract Thinking Factor	Sandhu
11. Eleventh Factor	(i)	Group Factor of Adolescent Thought–II	Sandhu
12. Twelfth Factor	(i)	Stating and testing of Hypotheses	Sandhu
13. Thirteenth Factor	(i)	Group Factor of Personality-II	Sandhu
14. Fourteenth Factor	(i)	Group Factor of Adolescent Thought-III	Sandhu

* Some factors from the bottom upwards could be eliminated through Scree test

In this frame of reference, it should not be forgotten now that factor analysis is a highly mathematical technique as well as advanced educational technology The various factors failing to appear in a definite way should be further subjected to empirical testing by carrying out highly imaginative studies using factorially known tests as reference points. The various tests used should cover as many diverse populations meeting fairly well the intended objective criteria of reliability and validity Similarly, the sizes of the samples should not invariably be less than four times the number of tests used. After having done this, the growth of factors should be clinically explored and the same be checked empirically to test whether the findings come from different chips of different blocks or the different chips of the same block. Whatever be the nature of those findings, they are bound to alter the already proposed structures of intellect. A periodic table of intelligence like the one in chemistry, if it exists, may become available for the benefit of learning psychologists. Until then, as it is apparent, the studies documented above simply as well as superficially reflect the possible structure of adolescent thought as imaginatively proposed by the Geneva School, using symbolic logic. Lastly, it will not be out of place to mention that the role of hints and cues in the development of concepts as well as problem solving is yet to be investigated with focus on acceleration of thought along with the varied modes of presenting subject matters, a very worthy aim of any first class educational system anywhere in the world.

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